The American Biology Teacher

Vol. 11 NOVEMBER, 1949 No. 7

PUBLISHED BY
The National Association of Biology Teachers

Entered as second class matter October 26, 1939, at the post office at Lancaster, Pa., under the Act of March 3, 1879.

THE AMERICAN BIOLOGY TEACHER

Publication of the National Association of Biology Teachers.

Issued monthly during the school year from October to May.

Publication Office—N. Queen St. and McGovern Ave., Lancaster, Pa.

Editor-in-Chief—John Breukelman, State Teachers College, Emporia, Kan.

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Subscriptions, renewals, and notices of change of address should be sent to the Secretary-Treasurer, John P. Harrold, 110 E. Hines Ave., Midland, Mich. Correspondence concerning advertising should be sent to the Managing Editor.

The entire Staff List will be found in the February and October issues.

Annual membership, including subscription, $2.50, outside United States, $3.00.

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Study of Typical Plant and Animal Cells
A Model-Making Project

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Instead of making the usual laboratory drawing of the typical plant or animal cell this fall, try this activity for a change. This exercise can be effective in helping ninth or tenth grade students to learn the parts of these typical cells. It may even develop into a skilled hobby.

First, get some plaster of paris, the kind that is sold at building supply places or lumber yards. Drug stores charge more for that which they sell because it is sterile. The amount will depend on the size and number of classes. Five pounds should be plenty for an average class and perhaps enough will be left over for students who want to make other models.

Ask the students to bring as many small cardboard boxes as they can find around home. The size should be about three inches long, two inches wide and one or one and a half inches deep. They should also bring a clean tin can and a little cold cream or grease. Each should have some child's modeling clay. Maybe your school has a supply of this or several students could go together and buy some.

First Day: Use a blackboard diagram of the typical cells to explain the parts, their function and the important differences. The diagram should be clearly labeled. Then list the steps in making the model.

1) Spread out old newspapers on the desk.
2) Put the clay in the bottom of the box and press out to about a half an inch in thickness. Smooth evenly.
3) Take a sharp instrument and make indentations on the clay for the cell parts. This will stand out in the finished model. Make clear and fairly deep designs.
4) When design is clearly made, grease the clay with cold cream or shortening.
5) Mix the powder of the plaster of paris with a small amount of water in the tin can. It should be a thick paste which will pour slowly into the box. A runny mixture will not harden as well. Pour on top of the clay design.
6) Put name on the side of the box and set in some convenient place to dry.

The students may work as partners, each making one of the typical cells.

Together they may compare parts, thereby learning some important differences.

Second Day: Finish the models. Break the sides of the box and remove the model. Trim the rough edges. Use a razor blade or some sand paper to smooth up before painting. Poster paint with a water base is recommended for the painting. The students may want to mount their "cells" on small wooden stands.

The models should be finished before the end of class and you can test them on what they remember. Use matching exercise for instance, matching labels with descriptions.

This activity in modeling is offered as an alternate to drawing since drawings can be used at many other times. It gives the student a little better idea of the cell "cube" than a flat drawing. It may be followed by an actual microscope lesson where students can realize there are many shapes and kinds of cells.

Be sure to let the student know about other models that can be made by the same process. These are a few of them: cells showing mitosis and reduction division; red and white corpuscles; nerve cell; euglena, amoeba and paramecium; types of bacteria; animal tracks and upper and lower teeth models. The shapes can be made out of clay instead of using a box. A clay impression can be taken of the teeth and the plaster of paris poured into it. In the same way actual animal tracks may be used as molds for plaster models. A little experimentation will open new ways of making models and new subjects to be made. This activity is just a starter.

A Simple Growth-Rate Experiment For An Elementary Course in Bacteriology

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Small institutions, often lacking in expensive equipment, can none-the-less offer courses in bacteriology which stimulate interest in the biological aspects of that science. The lack of equipment is often compensated for by simple techniques adapted to fit the particular laboratory. For instance, a group of students may easily determine some of the fundamental properties of a population growth rate. Each student is issued (1) a wooden slide box containing ten or more clean slides on each of which a square of known area is marked off, (2) a small pipette which is drawn so that one free drop equals approximately 0.01 cc., and (3) a small bottle. Each student, at his convenience, then partly fills the bottle with milk, and, after duly shaking the milk at each sampling, makes smears, using one drop of milk per given area, at regular intervals. The dried

* This paper is based on work done while the author was at Southwestern University, Georgetown, Texas.

The modification of the "Breed method" used by the author is as follows: The dried smear is fixed in methyl alcohol, then immersed in xylol to dissolve out the fat, then, after drying, stained in Loeffler's methylene blue solution (sat. sol. methylene blue in alcohol, 30 cc.; sol. potassium hydroxide, 1: 10,000, 100 cc.) five minutes, then rinsed in tapwater and allowed to dry. The bacteria can be seen as dark blue dots and rods against a colorless background, with no higher magnification than the 4 mm. objective. Bacteria are counted in several fields on a slide; the counts may be averaged and used directly to plot a growth-point, or the number of bacteria per unit volume of milk may be determined.

and stored smears are later stained after the "Breed method," and the bacteria counted. The resulting numbers of bacteria per field are plotted against time (see Fig. 1, an actual example from class data). Interpretation of the resulting curves, and their comparison with a curve based on the class' average data, provide insight into such varied matters as evaluation of statistics, dairy products examinations, and the ecology of "closed systems."

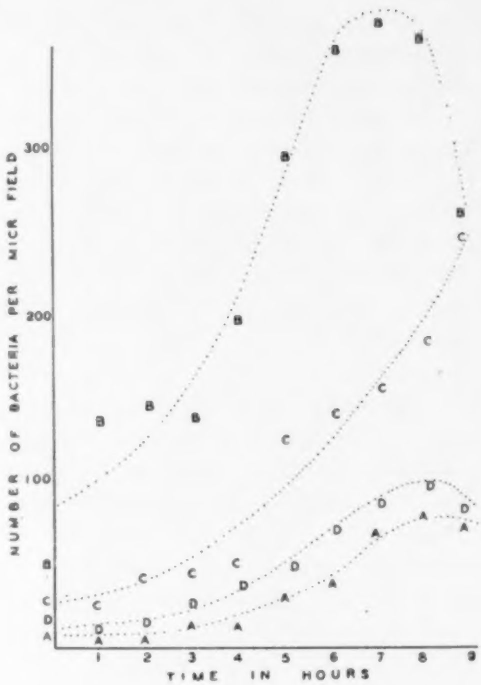

Fig. 1. Student determinations of growth rates of bacteria in milk samples. Since the Breed method of counting bacteria in milk does not distinguish between living and dead bacteria, the "maximum stationary phase" on the above curves should appear to continue indefinitely. The data, contradicting this expectation in curves A, B and D, may perhaps be explained as due to actual destruction of dead bacteria, agglutination, or similar phenomena in the rapidly changing medium.

Some Simple Physical Principles in General Biology

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and

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Many students in introductory biology courses lack an adequate background in the physical sciences. This deficiency poses an important problem, namely, *the selection of material for illustrating quantitative principles.* This material should be of such a nature that it can be understood with a minimum knowledge of the physical sciences. This paper has a dual purpose: 1) to stimulate other teachers to aid in the solution of this problem and 2) to contribute some material for the teaching of quantitative concepts in an introductory course.

Some simple physical laws can be shown to have a direct bearing on the determination of the form and function of organisms. These cases serve to emphasize the importance of the quantitative viewpoint in interpreting the phenomena observed in biological studies.

Relation of Surface to Mass

One of the simplest relationships—that of surface to mass—is one of the most rewarding. That surface and mass will increase at different rates is simply demonstrated and can be understood without any background in the physical sciences. A discussion such as the fol-

lowing will, by analogy, explain this relationship not only for cubes, but for other geometrical figures.

Assuming that two solids have the same shape, their surfaces are to each other as the square of their linear dimensions, while their masses are to each other as the cubes of their linear dimensions. For example, a cube 1 inch on each side has 6 square inches of surface and a volume of 1 cubic inch. If we double the linear dimensions to 2 inches on each side, the surface is now 24 square inches and the volume 8 cubic inches. The surface has increased 4 times (2 squared) while the volume has increased 8 times (2 cubed).

The cell membrane, the absorptive surfaces of the intestine and the respiratory surfaces of gill and lung are examples of physiologically active surfaces. There are many such surfaces which play an essential role in the dynamics of the organism. The rate at which materials pass through these surfaces is dependent upon the *area* exposed and the *efficiency* of the structure for its particular function. The requirements of an organism for oxygen, food, or water, on the other hand, depends directly on the mass of the protoplasm, all other things being equal. It is evident, therefore, that the surface-mass ratio has a determining effect on form and function whenever a dynamic imbalance of surface and mass develops.

Surface-mass relationships operate at the cellular level as well as at higher levels. There is considerable evidence to indicate that in any given type of cell there is a certain more or less constant ratio between the size of the nucleus and the cytoplasmic mass. Since materials can enter or leave the nucleus only by passing through the nuclear membrane, the surface area of the membrane limits the rate with which materials enter and leave the nucleus. Among larger protozoa, for example, the macronucleus is elongated, beaded, or irregular, thus exposing a greater surface to the cytoplasm than would be the case if it were spherical or oval as in most of the smaller protozoa. In the same manner the area of the plasma membrane acts as a limiting factor in the rate of absorption of substances required by the cytoplasmic mass, and so tends to limit the maximum size which the cell or protozoan can attain. In a cylindrical organism, increase in length without concomitant increase in diameter permits growth in size without materially altering the surface-mass relationship, a fact which may be correlated with the common occurrence of very greatly elongated ciliates, some of which attain a length of several millimeters. When the organism is greatly flattened, an increase in mass does not materially change the surface-mass ratio if growth occurs only in length and breadth without effecting thickness. Several species of Myxosporidia attain a considerable size, measuring from five to ten millimeters in length and breadth, while they are only one hundred microns or less in thickness.

The Critical Point

In the evolution of organ systems, the order in which they appear is made more comprehensible when it is kept in mind that the proportion of surface area to mass is decreasing with the increase in the size of the organism. A point is eventually reached when the surface area is inadequate to support the mass of protoplasm. At this *critical point*, the surface-mass ratio becomes a vital factor limiting the maximum size which the organism can attain without a change in form. For various important physiological processes the critical point is reached at a different stage of evolution, a fact which may be correlated with the

evolutionary order of the appearance of the various systems.

The molecular size of foods is larger than that of oxygen or of carbon dioxide and therefore are absorbed at a slower rate. Simple organisms may require a specialized digestive system although the body surface is sufficient to take care of the respiratory needs. We encounter this situation in coelenterates and flatworms. In general, molecules of nitrogenous wastes are of an intermediate size and the critical point for excretion is reached before that for respiration. Although the surface of the body of flatworms is adequate for respiratory needs, special excretory adaptations, such as flame cells and excretory tubules have been evolved. It is only among the larger invertebrates that such specializations as tracheal tubes, gills, and respiratory pigments are found.

As new psysiological interrelationships evolve, the ratio of surface to mass at which a critical point is reached may be greatly changed. Among annelids, the fluid-filled coelom and the haemolymph system facilitates the distribution of food substances. The movement of these body fluids carries foods away from the absorptive surface, resulting in the stepping-up of the diffusion gradient. The rate of diffusion is thus accelerated and a relatively smaller absorptive surface suffices in these forms. However, in larger annelids, e.g. *Lumbricus*, the surface of the digestive tube may be increased by a typhlosole, possibly indicating that the surface-mass ratio is again approaching a critical point.

Annelids provide other excellent examples of the physiological consequences of increased bulk. The elongation and coiling of the nephridial tubules is a specialization which increases surface area. The slow diffusion rate of oxygen in water and the low oxygen concentration in the tubes in which some of the aquatic annelids dwell is correlated with various adaptations for increasing the respiratory surface, such as external gills and the development of respiratory pigments.

The Exoskeleton

"In arthropods the exoskeleton is composed of dead material and encases the soft tissues. This type of skeleton interferes with continuous growth. The growth period in such forms is relatively short and periodic, that is, it occurs only during the periods when a new skeleton is being formed following the shedding of the old one. In vertebrates the living endo-skeleton does not in any way interfere with the growth of the organism; consequently many of these forms become massive. As a group the vertebrates are the largest of all animals. The difference in size between vertebrates and higher invertebrates in largely due to differences in the amount of muscular tissue. There is a relationship between the amount of muscular tissue and the amount of skeletal surface for muscle attachment. The increased amount of muscle and skeletal tissue imposes increased nervous, nutritive, respiratory, excretory, and circulatory requirements."* It is thus among vertebrates that changing surface-mass ratios are most strikingly illustrated.

The Vertebrates

The absorptive and secretory surfaces of vertebrates exhibit a variety of adaptations which are correlated with the decreased ratio of surface to mass imposed upon the organisms by their large size. In all vertebrates there is some form of internal folding which increases the total

* Meglitsch, P. A. and J. P. Wessel, *An Introduction to Biological Principles*, Burgess Publishing Co., Minneapolis, Minn., pp. 63–64. 1948.

surface of the gastro-intestinal tract. Among the elasmobranchs the spiral valve adds to the absorptive surface, while among other groups the elongation and coiling of the ileum serves the same purpose. Increased diameter of the colon slows the rate of movement of its contents, thus increasing the time for absorption of water, bile salts, and vitamin K.

Among fishes an adequate respiratory surface is attained through the agency of a pharyngeal gill system. Modern amphibia, all relatively small and capable of exchanging respiratory gases through the body surface, have a poorly developed lung with incomplete and sparse partitioning. Reptiles are provided with a lifeless, impermeable outer covering of scales. Their increased size and their loss of cutaneous respiration is compensated for by an increase in lung surface and a more effective separation of systemic and pulmonary blood streams.

Although the changing surface-mass ratio undoubtedly influences the development of most organ systems, there are a number of instances in which it must play but a minor role. The change from aquatic to terrestrial life imposes the necessity for a more economical use of water. This is probably correlated with an increase in the reabsorptive power of the urinary tubules, made possible by their increase in numbers and length. Warm-bloodedness increases the metabolic rate and thus demands an increased excretory surface in birds and mammals.

The Warm-blooded Animals

Among warm-blooded animals the high metabolic rate imposes a new strain on digestive, respiratory and excretory systems, as well as on the circulatory system which must distribute materials to the various body parts more rapidly or more efficiently. The four-chambered heart coupled with the relatively rapid pulse rate, the reduction of the renal portal system and the compensating development of the arterial supply to the kidney all serve to increase the efficiency of circulation. The increase in length and internal folding in the alimentary tract; the increase in the partitioning of the lungs and more efficient oscillatory mechanisms; an the increase in the number of renal corpuscles are all factors which have helped to make warm-bloodedness possible.

The maintenance of a constant body temperature depends upon a balance between heat production and heat loss. Many factors influence the rate of heat loss when the environmental temperatures are high. However, as environmental temperatures decrease the percentage of total heat loss through conduction and radiation at the body surface constantly increases. As a result the total surface area of the animal becomes an increasingly significant factor among mammals and birds living in cool or cold climates. Since the smaller animals have a relatively greater ratio of surface to mass, the amount of heat loss at the body surface will be higher per unit of mass than in more bulky forms.

The amount of heat produced depends upon the volume of the tissues, especially muscles, in which oxidative processes occur. In smaller organisms, therefore, there is a relatively greater amount of heat loss and the metabolic rate must be higher. Thus heart rate, body temperature, speed of reproductive cycle, etc., tend to increase in smaller organisms. A mouse is said to consume half its body weight in food in twenty-four hours, while man, for example, takes in about a fiftieth of his body weight in the same period. The net result is to place a limitation on the minimum size of warm-

blooded forms. All other things being equal, this minimum size will vary with the external temperature, and in colder climates the smallest warm-blooded animals would freeze. This is undoubtedly correlated with *Bergmann's Rule* which states that races living in cooler climates are larger in body size than races of the same species in warmer climates. Local temperature loss may cause discomfort, and even freezing, in relatively small parts which have a proportionally large surface. Thus fingers, toes and ears are usually the first body part to suffer cold. This is undoubtedly correlated with *Allen's Rule,* which states that the races of mammals living in cooler regions have relatively shorter tails, legs and ears than races of the sames species in warmer regions. It also applies to birds, with respect to relative lengths of beaks, legs and wings.

To Cut or Not to Cut!

DONALD S. LACROIX
Amherst High School, Amherst, Massachusetts

There seem to be several "schools of thought" in the matter of dissecting preserved specimens in the high school biology course. There are some secondary school biology teachers who require minute and careful studies of anatomy in worms, frogs, crayfish and what-not—who require the memorizing of bone names, muscle pieces and sundry other portions. Again, there are those teachers who suggest little or no dissecting—simply leaning on the text-book drawings. I suspect that between these extremes we find on the one hand the teacher who has taken several college courses in comparative anatomy and who is steeped in the tradition of memorizing a lot of "part" names; and on the other hand the teacher who never had much actual laboratory work with a dissecting kit, and is therefore afraid to tackle any "dismembering" with a bunch of high school pupils.

From the average high school (if such exists!) only a few pupils go on to college. Of these, still fewer will undertake any courses of a biological nature. Most of the boys and girls in the high school biology course will join the ranks now occupied by Mr. and Mrs. Average Citizen. Hence it would seem to be a waste of time to require these students to make detailed studies of the anatomy of preserved specimens. The logical procedure is to give the youngsters a chance to do some dissection—enough "opening up" of several types to observe the development of digestive systems, respiratory apparatus, reproductive organs, skeletal structures and so on—but without having to study and memorize many parts and minute pieces. Those students who enter institutions of higher learning to pursue medicine, surgery, nursing or other biological courses will get enough of that type of study when the time comes. Those who, upon graduating from high school are to become secretaries, clerks, machinists or ditch-diggers will have gained little from learning the names of all the bones in a cat's skeleton—but they should get a fairly good mental picture of how they themselves "tick" if they have had the opportunity to see the insides of several types of animals.

The usual preserved specimens mentioned above have been used from early times in school biology and certainly have a place in the sun. Greater interest

can be aroused by bringing in to the laboratory local animals or parts from slaughter houses. One of the most exciting experiences I have witnessed came about when a boy brought in the eye of a pig which his father had slaughtered. We had been studying eye-sight, vision and the usual models of the human eye, so that the pupils were familiar with the general terminology involved. A dissecting kit was placed in the hands of the boy who brought in the pig's eye, and with many suggestions from the surrounding "assistant surgeons" he went at it. Without any direction from the teacher, these boys took apart and identified with enthusiasm and much satisfaction the important parts about which they had been studying.

When the dissection of specimens is first introduced in the high school biology course, there are usually several pupils who throw up their hands and say they can't do it, or can't look at such things. In such situations, it is only necessary to collect the more hardy souls around a bench and start them off. In a few minutes their interest and pointed exclamations arouse the curiosity of the others to such an extent that the latter will come over. Before the laboratory period has ended, most of them will be clamoring for an active part in the work. If the teacher tries to force everyone to do the work, he may kill the latent interest which can better be aroused by allowing natural curiosity to take its course.

Youngsters will gladly bring in fish-heads and can be directed in examining gills, brain, mouth, and eyes. Parts of home-slaughtered animals can be procured by boys living on farms or can be gotten at local abattoirs. Chicken lungs with a piece of glass tubing inserted in the trachea make excellent demonstrations. Chicken feet can be dissected to show the action of tendons and the special perching adaptations of birds feet. One of the most interesting studies can be made by killing a snapping turtle (Chelydra) and removing the plastron. Leaving the turtle on its back, carefully cut away enough tissue to expose the heart. This organ will continue to pulsate for several hours after death and presents a beautiful study of heart action. If the outer skin is removed from a leg and an electric current from one or two dry cells applied intermittently to the muscles, another interesting series of observations is possible.

Leg bones with joints intact can be obtained from butchers and meat markets. By sawing them open longitudinally pupils can observe bone structure, joint formation, cartilage, marrow and ligaments. This is especially helpful in connection with the study of the skeleton in human physiology.

The student who intends to go to college and take up biology in some form or other, be it medicine, agriculture, zoology or any other course in this field, can be interested to such an extent that he will come in after school or during a free period.

INTERNATIONAL UNDERSTANDING

Education for international understanding is a fundamental responsibility of all levels from elementary to adult education. More than sixty national organizations cooperated in a conference held at Estes park during the past summer, the work of which centered about four main points: 1. coordination between campus and off-campus agencies, 2. specialized training, 3. general education, 4. a framework for international cooperation among colleges and universities.

The complete report of the Conference is being published by the *American Council on Education* and will be available very shortly.

Annual Convention of the
NATIONAL ASSOCIATION OF BIOLOGY TEACHERS
in conjunction with
The American Nature Study Society and The National Science Teachers Association New York City, N. Y.
December 27–30, 1949

TUESDAY, DECEMBER 27

10:00 A.M. Joint Session—Grand Ballroom, Hotel New Yorker. *New Scientific Trends.*

2:00 P.M. National Association of Biology Teachers—North Ballroom, Hotel New Yorker. TEACHING AIDS FOR BIOLOGY—FROM WITHIN THE CLASSROOM AND LABORATORY. Chairman: Dr. P. H. Betty Lockwood, President Elect, National Association of Biology Teachers.

"Teacher-Pupil Planning for Biology." Mr. Jesse Miller, Manhasset High School, Manhasset, N. Y.

"Student Activity as an Aid to Learning in the Biological Sciences." Rev. Francis E. Williams, C.S.V., M.S., Archbishop Stepinac High School, White Plains, New York.

"Enriching the Biology Program through Audio-Visual Aids." Brother Thomas Edward, S.M.S., M.S., Bishop Dubois High School, New York, N. Y.

"The Use of 2×2" Photomicrographs in Teaching Biology." Abraham M. Weckstein, Ph.D., Barringer High School, Newark, N. J.

"Preparation and Use of Color Slides in the Classroom." Brother Charles, F.S.C., Saint Mary's College, Winona, Minn.

"Horticultural Biology." Miss Lydia Elzey, State College, State College, Pa.

"Techniques in Photosynthesis and the CO_2–O_2 Cycle." Paul Brandwein, Ph.D., Forest Hills High School, Forest Hills, N. Y.

"A High School Science Service." Mr. James Harlow, University of Oklahoma, Norman, Oklahoma

"An Outdoor Laboratory—A Science Weekend Camp." Mr. Zachariah Subarsky, Bronx High School of Science, New York, N. Y.

"A Demonstration Activity in Human Physiology." Miss Dorothy Tryon, Redford High School, Detroit, Michigan

"Suggestions for Teaching the Human Eye." Charles E. Hadley, Ph.D., Montclair State Teachers College, Montclair, N. J.

"Accent on Man." Mr. Harold Nagler, James Madison High School, Brooklyn, N. Y.

WEDNESDAY, DECEMBER 28

10:00 A.M. Joint Session—Grand Ballroom, Hotel New Yorker. *New Scientific Trends*

2:00 P.M. National Association of Biology Teachers, Parlors F and G, Hotel New Yorker.

TEACHING AIDS FOR BIOLOGY—FROM OUTSIDE THE CLASSROOM AND LABORATORY.

"Aids for Teaching Personal Hygiene." Mrs. Marion Morris Hinse, Director, Educational Service Dept., Bristol Myers, Co., New York, N. Y.

"Aids for a Dental Health Program." Harry Strusser, D.D.S., Director, Bureau of Dentistry, Department of Health, New York, N. Y.

"Health Education Services from the National Tuberculosis Association." Miss Charlotte Leach, Consultant in Health Education, National Tuberculosis Association, New York, N. Y.

"Visual Aids for Teaching Green Plants and Photosynthesis." Mr. H. L. Bogart, Public Relations Director, Sugar Research Foundation, Inc., New York, N. Y.

"How a Botanical Garden Can Assist a Biology Program." Mr. G. L. Wittrock, Ass't. Curator Education, The New York Botanical Garden, New York, N. Y.

Other Aids for Conservation, Health, Disease, Plant and Animal Study will be presented and discussed briefly, and materials distributed.

(*Continued on next page*)

Thursday, December 29

10:00 A.M. General Session—Grand Ballroom, Hotel New Yorker

Program arranged by The New York Federation of Science Teachers

2:00 P.M. General Meeting of the Cooperative Committee, AAAS

6:30 P.M. Joint Dinner of the three societies, Hotel New Yorker

Friday, December 30

Former all-day field trips with our affiliate, The American Nature Study Association, have proven so popular, that another trip is planned for this year. Several shorter trips to local points of interest are also planned by the New York Federation of Science Teachers.

Editorial Comment

Learning Facts

In all the present-day discussion about relation-determining, curiosity-arousing, judgment-exercising and other goals of science education we are apt to forget one of the other fundamental and essential goals, fact-learning. Facts always have been and probably always will be the basis of science and the scientific method. The importance of science in society rests on exactly the same foundation—facts.

Few if any teachers will argue that the student gets much good out of memorizing a group of unrelated facts, or even related facts that he does not understand. Few if any biology teachers believe that forcing a student to memorize lists of technical names of plants and animals does much to give him either real knowledge or real appreciation of the living world (though a few act as if they believed it). But this is not the point at all. Many science teachers and educators talk as if we must decide *between* facts and principles; as if emphasizing one of these must be at the expense of the other. They deride "fact learning" and glorify principles, relationships, or what-not. This is a short sighted view. We must make sure that we emphasize *both* facts *and* principles, since neither means much without the other.

The job is to get the student to see a principle as a unified expression of a lot of facts. He must come to realize that relationships do not exist in vacua. They only exist between something and something else. In science these "somethings" are facts.

In our own courses a few students after each final exam ask: "Why didn't you make the tests general like the final? Why did you ask such specific points on the tests?" The majority of them of course have by the time of the final come to see that only after a period of fact learning is the student in a position to deal with broad generalizations. Actually each successive test includes more generalizations and few specific points that its predecessors, but many students do not catch on to this until the end of the semester.

Whatever the goals or aims of a general biology course—economic use, interrelationships with other sciences, importance in modern civilization, appreciation of nature, general culture, understanding the scientific method, health and hygiene, development of hobbies and leisure-time interests, many others—the foundation stones and instruments for their attainment are facts.

On Understanding Science

When on September 23 the news came over the radio that our instruments had detected an atomic explosion in Russia, I happened to be reading the first chapter of Conant's thought-provoking little book *On Understanding Science*.* I had read it several times before, but now suddenly it took on more meaning. Conant writes as follows: "Some understanding of science by those who shape opinion is therefore of importance for the national welfare. Such a statement made a decade ago might have seemed a presumptuous claim on the part of scientists. Today, with the as yet unsolved riddle of international control of atomic energy hanging ominously above us, such a statement may seem so obvious as to require no elaboration." And in another place in the chapter: "Even a highly educated and intelligent citizen without research experience will almost always fail to grasp the essentials in a discussion which takes place among scientists concerned with a projected inquiry. This will not be so because of the layman's lack of scientific knowledge . . . it will be to a large degree because of his fundamental ignorance of what science can or cannot accomplish, and his consequent bewilderment in the course of a discussion outlining a plan for a future investigation."

The point of this editorial, which up to now consists mostly of quotations, is simple. Your editor, having found Conant's book highly interesting and instructive, recommends it as outside reading for all who teach science. It is becoming more and more important for laymen to understand, not the details of science or of any particular one of the sciences, but the "Tactics and Strategy of Science." Progress, as we have come to think of it, is not possible without continued and expanded scientific research. This research must be in the pure sciences and in the planning of programs of applied science. The financial and other support of the program of scientific advance must come from the people, through the medium of enlightened public opinion—in other words, education and information. In a democracy, only the people can make longrun decisions.

It is not that the announcement of the Russian atomic explosion made any fundamental change in world affairs. Only the blind or the incurable Pollyannas ever thought that the United States could retain exclusive possession of the atomic bomb, if indeed they ever had it. But the myth of an "atomic secret" had a powerful hold on the people, and that hold is now broken. Now more people realize that everyone is involved in the decisions as to what to do about the bomb. But this only is the beginning; such decisions will have to be made regularly in the near and the predictable future.

* CONANT, JAMES B. *On Understanding Science.* Yale University Press, New Haven, Conn., 145 pp. 1947.

THE NEW YORK MEETING

As in the past THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS will meet with the AAAS in New York, December 27 to 29. Headquarters are at the Hotel New Yorker, but reservations for this or other hotels are to be made through the Housing Bureau, Sylvia T. Peltonen, Manager, 500 Park Avenue, New York 22, New York. The complete program of NABT and cooperating societies appears on page 171. As usual, *The American Biology Teacher* will print as many of the papers presented at the programs as possible and will attempt to bring other items of interest. Official proceedings of the Association, reports of officers, and the like will be published as soon as practical, beginning with the February issue.

Safety Measures for Students Who Hunt Game

HUNTING ACCIDENTS MAY BE AVOIDED IF YOU:

1. Never point a gun at anyone unless you want to shoot him.
2. Never have your gun loaded in a car or when walking on the highway.
3. Never run with your finger on the trigger.
4. Never shoot through brush.
5. Never shoot over the brow of a hill.
6. Never hold your hand over the end of the barrel of a gun.
7. Never look into the barrel of a gun unless gun is broken.
8. Never lean on your gun.
9. Never climb a fence with your gun in hand; lay it through the fence and climb over.
10. Never shoot across a highway.
11. Never shoot toward a house, barn or livestock.
12. Always use the proper sized shells for your gun.
13. Always carry gun with safety on—check this frequently.
14. Always carry the gun pointing up in the air or down toward the ground.
15. Always clean gun before using.
16. Always lay your gun *down on the ground* when picking up your game.
17. Read *Game Laws* and obey them.
18. Secure permission of landowner before trespassing.
19. Never cut fences or leave gates open.
20. Display license on your back.

GABE SIMON,
Camp Crag (*Y.M.C.A.*),
Medina, Ohio

Preparation of Manuscripts for Publication

JOHN BREUKELMAN
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Since the supply of reprints of the authors article on the preparation of manuscripts* has been exhausted and there is still a regular demand for them, the article is being reprinted, with slight changes and additions, most of which have been prompted by letters from readers of *The American Biology Teacher* and contributors of articles.

Manuscripts of excellent content often reach the editor's desk in such form that they have to be almost completely reworked before going to the printer. Sometimes teachers write for directions for preparing papers for publication, also there have been several suggestions to the effect that a set of instructions be printed in *The American Biology Teacher*. These directions apply particularly to our own journal, although the procedures are more or less standard. It is hoped that this article may stimulate readers with suitable ideas to get them into shape for submitting to the journal.

The manuscript should be typewritten, double spaced, on one side only of a standard weight white paper, $8\frac{1}{2} \times 11$ inch size, with margins of at least an inch on all sides. The writer should keep a carbon copy for reference and as insurance against loss in transit of the original.

* Breukelman, John, Preparation of Manuscripts for Publication, *The American Biology Teacher*, Vol. 6, No. 1, pp. 20–24. October, 1943.

The title should be placed at the head of the first page of the manuscript, at least an inch below the top of the page. It should be short, but still indicate the content of the paper as accurately as possible. The wording of a title is necessarily a compromise between brevity and accuracy. In the case of longer articles (about 1200 words or more) the author's name is placed below the title, next his school or other professional connection, followed by the city and state. In the case of shorter articles, news items, reports, editorials, etc., the author's name, professional connection and address are placed at the end of the manuscript.

Subheadings are centered if they are all of equal rank; if there are primary, secondary, etc., headings, the primary ones are placed at the extreme left, the secondary ones indented 5 spaces, those of the third order 10 spaces, and so on.

It goes without saying that the wording, grammar and punctuation should be checked several times. It is well to have the entire article, both the rough draft and the finished form, read by several other persons. Any words that are to be CAPITALIZED in the printed article should be capitalized in the copy; words to appear *in italics* should be underlined in the copy; those to appear in **bold face** should be underlined with a wavy line.

Consistency is important; do not write "vigor" in one place and "vigour" in another, or "Amoeba" in one place and "ameba" somewhere else in the same article. Abbreviations should be double-checked. For example THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS may be correctly designated as NABT or N. A. B. T., but not both ways in the same paper. And please, only one of these in the same article: cc, C. C., cu. cm., ml.

References are listed in various ways. For *The American Biology Teacher* the most common forms are as follows:

For books: Author (last name first), Exact title of book (underlined), Name of publisher, Address of publisher. Number of pages. Illustrations (if any). Publication date. Price.

For magazine articles: Author, Title of article, Name of magazine (underlined), Volume, number and page or pages. Date.

For bulletins, government publications, theses and the like, no standard form can be specified, since conditions are so variable. Some samples of references are given herewith:

Morgan, Ann Haven, *Field Book of Ponds and Streams*, G. P. Putnam's Sons. New York, N. Y. 464 pp. Illus. 1930. $3.50.

Riddle, Oscar, The Preparation of High School Science Teachers, *American Biology Teacher*, Vol. 5, No. 3, pp. 63–65. Dec. 1942.

Palmer, E. Laurence, Fields in Winter, *Cornell Rural School Leaflet*. Cornell University, Ithaca, N. Y. Jan. 1940.

Bell, W. B., and Preble, E. A., Status of Waterfowl in 1934. *U. S. Dept. of Agric. Misc. Pub. No.* 210. Washington, D. C. 1935.

Mentzer, Loren W., *Wildlife Conservation.* Unpublished thesis, Kellogg Library, Kan. St. Tchr. Coll., Emporia, Kan. 1941.

If the topic under discussion is seasonal in nature, the paper must be submitted in plenty of time. For example, manuscripts for *The American Biology Teacher* are sent to the printer on the 22nd of the second month before issue. They should be in the editor's hands several weeks before the deadline, to allow for planning of the issue and for any correspondence that may be necessary. An article dealing with a Christmas subject, which should preferably appear in the November issue, goes to the printer September 22. Such a paper should be received by the editor not later than the first of September.

Many articles are improved by one or more illustration; for some, illustrations are essential. These may be either photographs or drawings. Since the publica-

FIG. 1. Size, arrangement and contrast just right to show the detail which tell the story for which this picture is intended.

tion of illustrations is relatively expensive, they should be selected with care so as to illustrate specific points and to fit in well with the topic under discussion.

Photographs must be clear, of relatively high contrast and glossy finish, and of such size and arrangement as to bring out the desired points. Some contrast is lost in the half-tone process; one should not submit any pictures that lack clearness and detail in either the lightest or the darkest portions of the significant area. If the shadows are completely black or the highlights completely white the picture will not make a good reproduction. The accompanying photo-

FIG. 2. This picture would be improved by a plain light background, giving more contrast between the instruments and the background.

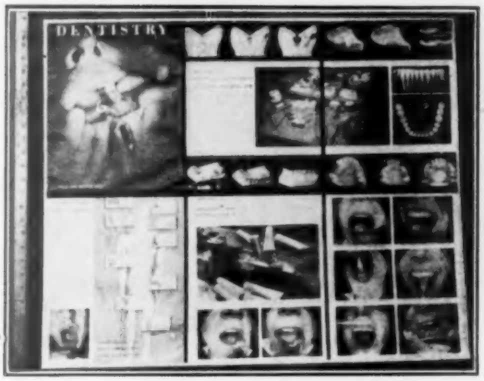

FIG. 3. As an illustration of a type of wall chart this picture is satisfactory; if it were intended to show details it would be too small and lacking in contrast.

FIG. 4. This picture is satisfactory as an illustration of the project as a whole; as in Fig. 3, the details are much too small for individual illustration.

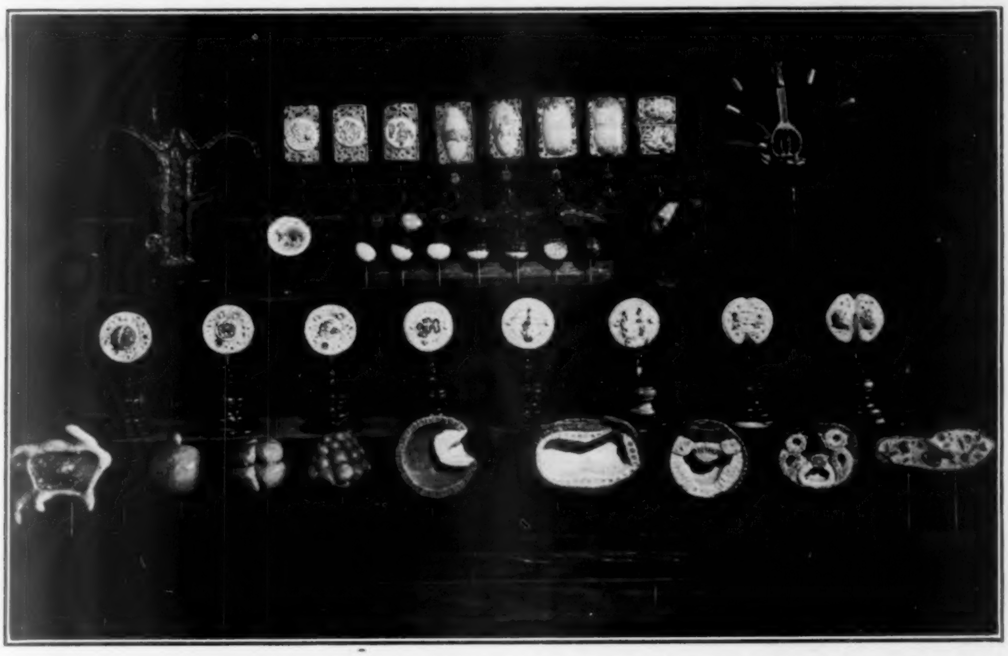

FIG. 5. The rather excessive contrast is justified in this picture since it makes the individual models stand out more clearly.

graphs, all of which have appeared in previous issues of *The American Biology Teacher*, illustrate several of the most important considerations.

Drawings should be made in india ink or other jet black ink on smooth white paper. They may be very simple, in fact the simplest drawings are often the most effective ones. They should ordinarily be drawn at least twice as large as they are to appear in print. The reduction smooths out irregularities and in general improves the appearance of the figure. Figures 6, 7 and 8 are reproduced at the size drawn, at half size and at quarter size, illustrating the effect of reduction on irregularities, contrast, distinctness of lines and stippling, legibility of lettering,

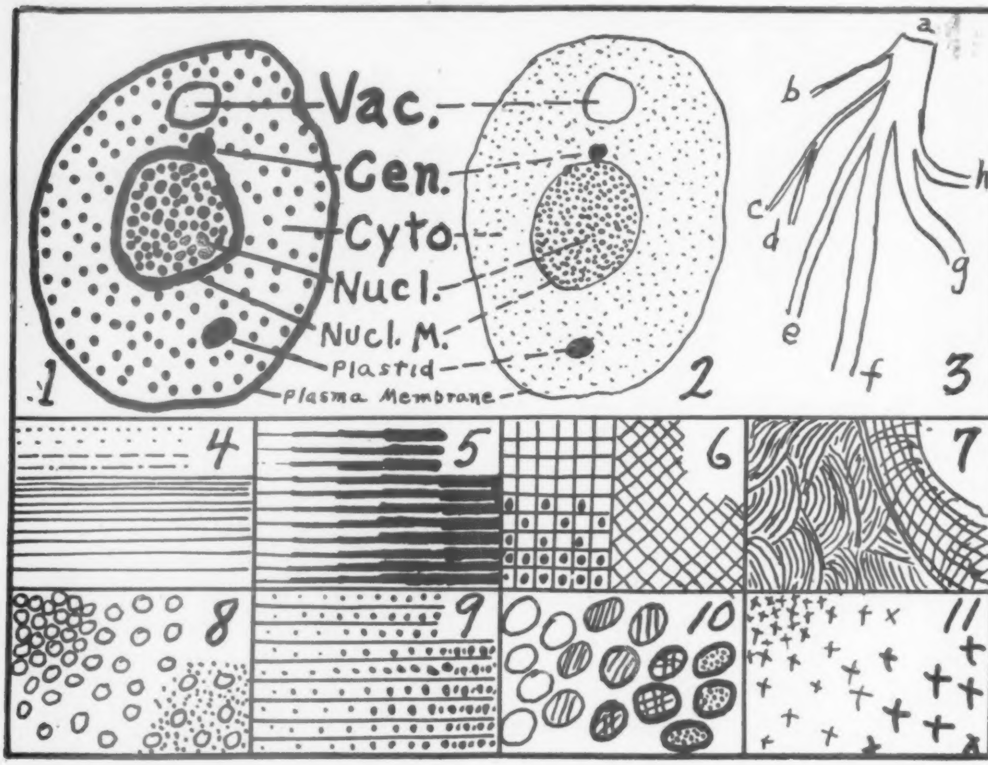

FIG. 6. Drawing reproduced full size, with all irregularities appearing as drawn.

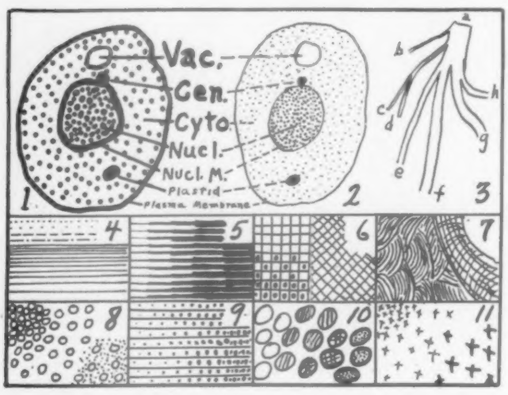

FIG. 7. Fig. 6 reduced to half size; note smoothing of irregularities.

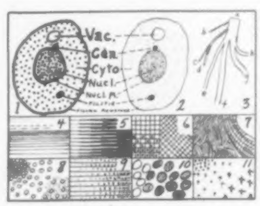

FIG. 8. Fig. 6 reduced to quarter size; note "washing out" of stippling in cell 2 and disappearance of dotted lines in block 4, running together of lines at 3b, reduction of smaller labelling to a size too small for legibility, effect of hatching in block 7, etc.

and the like. Note that while contrast is lost in half-tone reproduction of photographs, it is increased in reproduction of drawings. The other drawings have appeared in previous issues of *The American Biology Teacher.*

Lettering should be large enough so that the smallest letters, (e, o, etc.) are at least a millimeter high in the printed figure. Therefore if the illustration is to be reduced to one half the original size, the smallest letters in the labelling should be at least two millimeters high, and so on for other degrees of reduction.

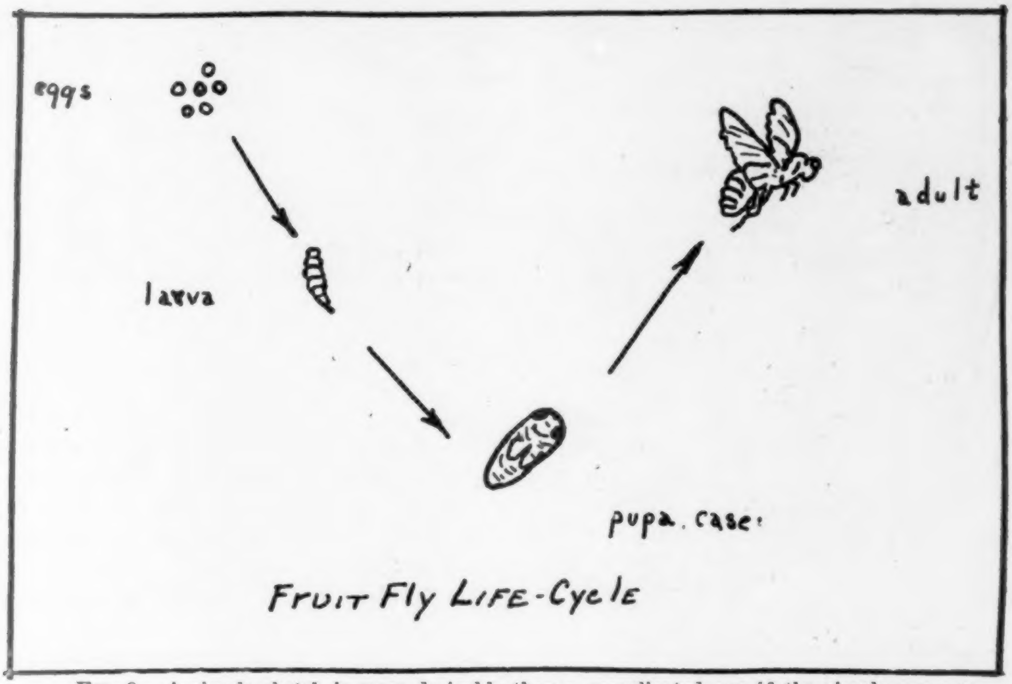

FIG. 9. A simple sketch is more desirable than a complicated one if the simple one can bring out the point that is to be made.

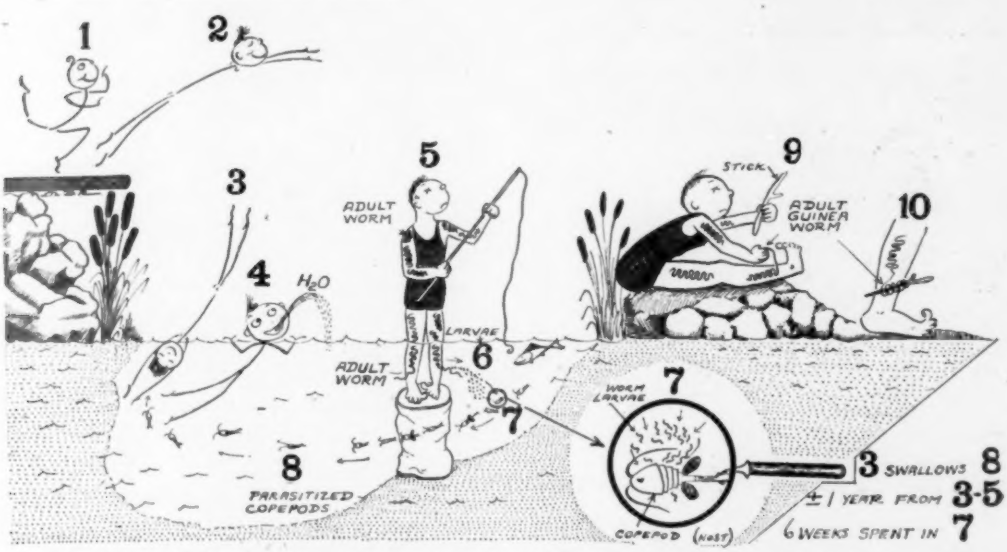

FIG. 10. A simple drawing of the cartoon type may be very effective in bringing out a complicated relationship, here the life cycle of the guinea worm.

The following quotation from a recent technical article* applies equally well here:

* Riker, A. J. The Preparation of Manuscripts for Phytopathology, *Phytopathology*, Vol. XXXVI, No. 11, pp. 953–977. Nov. 1946.

Finishing Items

1. It is hoped the author can answer "yes" to the following questions:

(a) Have you critically reexamined the methods, experiments, and conclusions?

(b) Will further repetitions of the work yield the same results and conclusions?

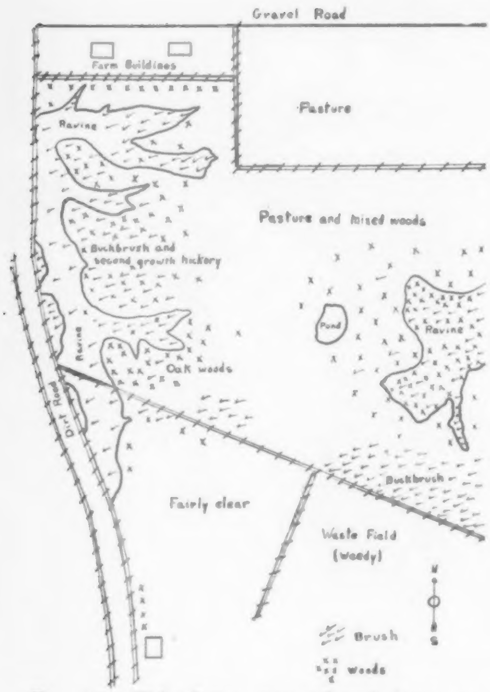

FIG. 11. This figure was reduced from approximately 6×8; any further reduction would have made the lettering too small.

(c) Have you eliminated all unnecessary materials from text, tables, and figures?

(d) Have two qualified colleagues criticized the manuscript?

(e) Has a competent statistician examined the tables and calculations?

(f) Have you met the conventional requirements regarding illustrations, tables, legends, and references to them? Will the text figures and tables fit properly on the printed page?

(g) Is there a reference in the text to every table, figure, and item in the "Literature Cited"?

(h) Have you checked every entry in the "Literature Cited" against the original?

(i) Have you prepared a table of contents showing the ranks of various headings and subheadings?

(j) After the paper was finished, did you lay it aside for a month and reexamine it critically with a fresh viewpoint and without bias?

(k) If required, has the proper administrative officer approved it?

Obviously, not all the points mentioned in the above apply to manuscripts intended for *The American Biology Teacher*; some apply to all manuscripts, all apply to some manuscripts. Those that do apply should be carefully considered.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, founded in 1848, is the only national body representative of all the sciences. With its 211 affiliated and associated societies and state academies of science, it is by far the largest and most influential scientific organization in the world. These affiliates are grouped into seventeen sections and subsections—from A (Astronomy) to Q (Education)—each administered by a committee of six including chairman and secretary in addition to representatives of societies affiliated with the section. The Association has about 45,000 individual members most of whom elect to receive either *Science*—a weekly journal primarily for technical scientists; or *The Scientific Monthly*—an authoritative less technical treatment of progress in science. (A member may receive both publications at a special combination rate by adding \$3.50 to the annual dues of \$6.50.) About one quarter of the membership have become fellows through their scientific contributions and attainments.

The *AAAS* seeks not only to further cooperation among scientists in all the diverse fields but also it is increasingly concerned with the improvement of human welfare and in a better public understanding of the interrelations of science and human progress.

The National Association of Biology Teachers is one of the affiliated Societies, meeting December 27 to 29 at the Hotel New Yorker. Make your reservations early.

ELECTION NOTICE

(The Nominating Committee appointed by the Executive Board has submitted the following list of nominees for offices of The National Association of Biology Teachers for the ensuing year. The Secretary-Treasurer is sending ballots to all members.)

For President:

RICHARD L. WEAVER—B.S. Pennsylvania State College; Ph.D. Cornell University, serv-

ing as Pack Fellow three years. Taught for three years Biology, Nature Study, and Science Maumee Valley County Day School in Toledo, Ohio; three years at Dartmouth College; one year at the University of New Hampshire; now serving as Program Director for the North Carolina Resource-Use Education Commission assisting public schools, teachers' colleges, and non-school agencies to increase their emphasis on conservation, biology, science teaching, and wise resource use. Taught in summer camps at Oglebay, Wheeling, West Virginia; Lost River Nature Camp; and at Plymouth Teachers College, New Hampshire. For three years served as Educational Director of the Audubon Nature Center at Greenwich, Connecticut. Membership chairman for the Wilson Club for three years; secretary-treasurer of the American Nature Study Society since 1943; served as secretary of the New Hampshire Audubon Society and the North Carolina Bird Club. Regular contributor to *The American Biology Teacher* and to numerous other scientific and educational journals.

Lee R. Yothers—Biology instructor and head of Science Department, Rahway High School, Rahway, New Jersey; part time Zoology instructor at Union Junior College, Cranford, New Jersey. B.S. University of Pittsburgh; M.A. Teachers College, Columbia University, New York. Member of The American Association for The Advancement of Science, National Association of Biology Teachers, National Association for Research in Science Teaching, National Science Teachers Association, Central Association of Science and Mathematics Teachers, New Jersey Science Teachers Association. Associate Editor and contributor of *The American Biology Teacher,* Author of articles in other scientific journals; Guest-editor "Field Trip" issues I and II of *The American Biology Teacher.* Served two years on executive committee of the New Jersey Science Teachers Association, Biology section chairman and Vice-president; Past membership representative for the National Association of Biology Teachers; State Director for the National Science Teachers Association in New Jersey.

President of New Jersey Science Teachers Association, 1949–50.

For First Vice-President:

Charles E. Packard—A.B. Bates College; M.S. Yale University; Graduate work, University of Illinois, Woods Hole, University of Cincinnati, Boston University Extension. Has taught biology and related subjects in grades, high schools, Bates College, Allegheny College, Cincinnati University, New Hampshire University, University of Maine, Alfred University, and is now Associate Professor at Randolph-Macon College for Men, Ashland, Virginia. A contributor to newspapers, periodicals such as *American Biology Teacher, Portland Maine Sunday Telegram, Christian Science Monitor, American Naturalist, School Science and Mathematics, School and Society* and others. He is a member of Phi Beta Kappa, Virginia Academy of Science, National Association of Biology Teachers, American Microscopical Society, National Education Association.

Harvey E. Stork—A.B. Indiana State Normal College, M.A. Indiana University, Ph.D. Cornell University, additional study at Sorbonne. Has taught in high schools, Cornell University, University of Iowa, and at present is professor of Botany, Carleton College. Was Research Associate, University of California; member botanical expeditions to Central America; Naturalist, Western National Parks, member University of California Botanical Garden Expedition to South America; Field Director, Explorers' Camp for Boys, Hesperus, Colorado. He is a Fellow, A.A.A.S. and a member of Botanical Society of America, Torrey Botanical Club, New York Explorers' Club, Minnesota Academy of Science' president in 1933 and National Association of Biology Teachers.

For Second Vice-President:

Sister Mary Thomasine—M.A. Mt. Mary College, M.S. and Ph.D. Marquette University, Graduate work at University of Minnesota, Catholic University of America, and Laval University, Quebec, Canada. Taught in high schools of Wisconsin and Michigan, and is now chairman of the Biology Department of Mt. Mary College, Milwaukee, Wisconsin. Author of various articles on biology teaching. She is a member of the National Association of Biology Teachers and at present is the Wisconsin Membership Chairman for NABT.

Dorthy C. Miller—A.B. Indiana Central College, Indianapolis, Indiana; M.A. Indiana University; Ph.D. Cornell University, Ithaca, New York in Nature Study under Dr. E. Laurence Palmer. Has taught Biology in High School and Junior College and at present is Iowa State Teachers College, Science Department teaching Biological Science for the Elementary Teachers. First-president of Biological Section Indiana State Teachers Association; chairman of Camping Committee of the National Association of Biology Teachers.

For Secretary-Treasurer:

John P. Harrold

THE STAFF

In order that readers may know who carries the chief responsibilities in the activities of THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS and *The American Biology Teacher* it is the policy of the journal to publish twice a year, in the November and February issues, a complete list of all staff members. Lists of chairmen and personnel of committees are published in connection with reports of their activities.

All these individuals are deeply interested in the improvement of both the association and the journal. They welcome suggestions from members and are ready to give assistance to anyone interested in writing items or other articles for the journal.

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The A.N.S.S. has always met with the A.A.A.S. and plans to continue to do so. We have never had a convention reservation fee but have encouraged members to register with A.A.A.S. They have been able in years past to pay the costs of projection equipment for our meetings and other affiliated groups. They are no longer able to do so but will share these costs with us on a pro-rata basis which will be determined by how many of our members are members of A.A.A.S. and how many of the people who attend our meetings have registered with A.A.A.S. The registration fee for members of A.A.A.S. is $2.00 and for non-members, $3.00.

We urge you to register with A.A.A.S. as this will help reduce our convention expense and keep us from having to charge a separate fee. You can register in advance and receive the catalogue of the combined meetings and your admission card early in December, by sending your check to Dr. Raymond Taylor, A.A.A.S., 1515 Massachusetts Avenue N.W., Washington, D. C.

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If you enjoy The American Biology Teacher, have some friend send in this application.

THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS ☐ NEW ☐ RENEWAL

JOHN P. HARROLD, Secretary-Treasurer,
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I hereby apply for membership in The National Association of Biology Teachers and enclose $2.50* as my annual membership dues $2.00 of which is for a year's subscription to the American Biology Teacher. (Subscription may not be had separately)

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* Outside of United States $3.00.

RECENT PUBLICATIONS

Neo-Antergan, Merck & Co., Inc., Rahway, New Jersey. pp. 15. 1949.

A description of a new antihistamine which gives promise of great relief to certain types of allergies.

Hymes, James L., Jr. *How to Tell Your Child About Sex.* Public Affairs Pamphlet No. 149, Public Affairs Committee, Inc. 22 East 38th Street, New York 16, New York. pp. 32. 1949. 20¢.

Brief treatment of the vocabulary developmental stages, questions, and general problems involved in sex education of adolescent children.

Blake, Emmet R. *Preserving Birds for Study.* Chicago Natural History Museum, Chicago, Illinois. pp. 38. 1949. 30¢.

An unusually clear and compact treatment, including all steps in the preparation of study skin and anatomical specimens, lists of materials and equipment, and shipping directions.

To Our Members:

A large part of the success of **The American Biology Teacher** is due to the generous support that our advertisers have given us.

We owe it to ourselves, as educators, to become more familiar with the abundance of excellent teaching aids and devices that these concerns produce.

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If you know of any firm that would benefit by advertising in our journal, notify Managing Editor Irving C. Keene, Brookline High School, Brookline, Mass.

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13×264	Size 21″ to 26″,	doubly injected	1.75	20.75
Necturus				
13×425	Size 11″ to 14″,	arteries injected	1.75	18.00
13×4251	Size 7″ to 10″,	arteries injected	1.50	15.00
13×426	Size 11″ to 14″,	doubly injected	2.25	22.50
13×427	Size 11″ to 14″,	triply injected	3.00	28.00
Bullfrogs (Size of frogs are *body* length and do not include length of legs.)				
13×514	Size 7″ to 8″,	arteries injected	2.75	26.50
13×5141	Size 5″,	arteries injected	2.50	24.00
13×515	Size 7″ to 8″,	doubly injected	3.00	30.50
13×516	Size 7″ to 8″,	triply injected	3.50	35.00
Grassfrogs				
13×545	Size 3″ to 4″,	arteries injected	.75	7.50
13×546	Size 2½″ to 3″,	arteries injected	.60	6.00
13×5461	Size 3″ to 4″,	doubly injected	1.25	12.00
Turtles				
13×6872	Size 6″ to 8″,	arteries injected	1.75	17.50
13×688	Size 8″ to 10″,	doubly injected	2.75	27.50
Pig Embryos				
13×877	Size 8″ to 11″,	arteries injected	2.25	21.75
13×878	Size 8″ to 11″,	doubly injected	2.75	27.50

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